

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Woody Tang, et. al
Assignee: Mosel Vitelic, Inc.
Title: Methods of Reducing or Removing Micromasking Residue Prior to Metal Etch Using Oxide Hardmask
Application No.: 10/649,099 Filing Date: 08/26/2003
Examiner: Dahimene, Mahmoud Group Art Unit: 1765
Docket No.: M-12977 US Confirm: 4957

San Jose, California

VIA EFS-WEB
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**DECLARATION OF GEORGE KOVALL
Pursuant to 37 CFR 1.131 Antedating a Reference**

Dear Sir:

I, George Kovall declare as follows:

1. I am a named co-inventor of the above-identified patent application.
2. Together with my co-inventors Woody Tang and Yi Ding we successfully reduced to actual and constructive practice the invention disclosed and claimed in our above-identified patent application prior to the June 20, 2003 filing date in the U.S. of the Doshita reference US 2003/0235987 A1.
3. Rather than repeating the objective facts corroborated in the accompanying "Declaration of Harki Singh Pursuant to 37 CFR 1.131 Corroborating Date of Actual Reduction to Practice" I adopt them here as also my own. I work at MVC together with Harki Singh and consulted with him in the formation of his declaration. There are certain things that Harki Singh cannot testify to and instead I will be supplying the missing information.

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4. First as to chain of custody and sources of evidentiary documents used here, my Exhibits A and B here are the same as the redacted ones of Harki Singh. Additionally I provide a redacted Exhibit C (Chemical analysis of the micromasking residue). The principal inventor is Woody Tang, and as Harki notes, Woody is no longer with the company. Woody took most of the photomicrographs in-house at MVI (same facilities as those currently occupied by MVC) and he also kept a laboratory notebook. Page A.7 of Exhibit A is a true copy to the best of my good faith belief and recollection of a page in Woody's laboratory notebook that shows at its bottom the etch recipe used to produce the successful wafer number Wf-724(784)-22. The redacted dates are, as Harki also notes, prior to the 6/20/2003 date of the Doshita reference. Page A.8 came from a different notebook where experimental micrographs were kept. When Woody left the company some of his left-behind materials were thrown into a paper box. When I was recently asked to prepare this Declaration, I located Woody's box and rummaged through it. I was not able to find the original laboratory notebook in there from which A.7 was copied or the micrographs book where A.8 came from. However, I did find left-behind photocopies of the pre-redaction version of Exhibit A page A.7 as well as page A.8 in Woody's box. As I recall it, we used these photocopies of A.7 and A.8 to form part of the Mosel Vitelic Invention Disclosure form (Exhibit A) that appears to have been sent to the Sjkerven Morrill law firm for constructive reduction to practice. I am given to understand that soon after we sent in the Invention Disclosure, the Sjkerven Morrill law firm disbanded and the file ended up in the hands of the MacPherson Kwok law firm, a practice that splintered off from Sjkerven Morrill. Patent attorney Gideon Gimlan was given charge over this Invention Disclosure and he worked diligently with Woody Tang to reduce the invention to constructive practice. Note that our 8/26/2003 filing date is just barely two months after Doshita's 6/20/2003 filing date. It is my recollection that prior to 6/20/2003 our patent application was near finished and there was just some final tweakings and corrections

to be done as well as signing off on the formal papers (our inventors' declaration was signed 8/19/2003). At the time I that was recently asked to prepare this Declaration, attorney Gideon Gimlan relayed to me by phone that he had just discovered the originally signed Mosel Vitelic Invention Disclosure form (Exhibit A) in the back of the law firm's file folder. He had also found a copy there of my Exhibit C which I will shortly describe. Custody of the originally signed Mosel Vitelic Invention Disclosure form (Exhibit A) remains with the MacPherson Kwok law firm. The copy I have been furnished with appears true and correct to the best of my recollection.

5. Referring to Exhibit A, (Mosel Vitelic Invention Disclosure form), the redacted date of submission to the law firm on the front cover sheet (page A.1) is prior to the critical Doshita date. The redacted dates on my Exhibit C precede those on Exhibit A, and as I shall detail below, Exhibit C demonstrates to some extent that I and my co-inventors had come into appreciation of the nature of the micromasking residue and how to broadly attack it before the dates of Exhibit A. Actually we had suspected what the structure of the micromasking residue was even before that and Exhibit C merely objectively verified our original suspicions.

6. On page A.3 of Exhibit A, under paragraph V, the first of the confidential in-house Process Module Report presentations, PMR-xxxx-wt to was to in-house technical staff including Harki Singh, whose supporting declaration accompanies my present Declaration. In paragraph IX of page A.3, the date given for actual experimental work (redacted) corresponds to the last set of experimental results in Woody Tang's notebook page (page A.7) for wafer number 724 (784)-22 and showing an end point (EP) designation of 39 seconds. Although this page does not explicitly set forth the chlorine-based "sputter etch" recipe used for the experiment, it is my firm recollection and conviction that indeed this was the successful etch result were we experimentally confirmed our suspicions that a combination of a chlorine-

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based chemical attack on the anchors of the micromasking residue, combined with physical bombardment (we used Argon) would effectively remove the undesirable residue. Although hard to see, the comparison photo micrographs at page A.8 demonstrate the successful reduction to actual practice. Wafer Wf-724(784)-22 is substantially free of the oxide floor roughness or texturing that plagues wafer Wf-724(784)-25 on the left. This was intended to be a before and after set of pictures. The oxide floor roughness or texturing is understood to correspond to the presence of micromasking residue left behind after a preceding TiN ARC etch. Generally the following aluminum stack etch leaves behind only the bubbled or textured oxide floor after the aluminum metal lines (visible on page A.8) are formed. However, on rare occasions, the oxide floor bubbles or roughening are accompanied by left behind aluminum. The latter is highly undesirable because it can short the closely spaced metal lines. By producing a smooth (nontextured) oxide floor in wafer Wf-724(784)-22 we had demonstrated that we had gotten rid of the micromasking residue that presented itself after the TiN ARC etch and was difficult to get rid of.

7. A yet better showing of the removal of the micromasking residue is seen on page A.9 in the "before" and "after" pictures for the experimental run designated as 693(231-14) where the before micrograph shows clearly the speckles of micro residue whereas the after results show that these micro residues have been successfully removed with our chlorine-based "sputter etch" process.

8. We coined the term "sputter etch" for lack of a better terminology at the time of invention. The intent was to convey that we were both chemically etching the metallic anchors of the residue (the Ti containing anchors -as shall be better seen when I discuss Exhibit C) and we were physically bombarding or sputter attacking the tops of the residue so that when the anchors weaken, the residue breaks off.

9. Referring to page A.5 of Exhibit A, this inventor signature page of our invention disclosure has signature dates (redacted) prior to the critical Doshita date and the bottom paragraph clearly indicates that the metal etch recipe is a "chlorine based" one which is "sputter-enhanced" in order to eliminate micromasking and consequentially reduce the roughness in the oxide floor after aluminum etch. We clearly indicate our appreciation that the residue has a "metallic component" (in the base anchors --not stated on A.5) as well as a "silicon oxide" umbrella that shields the "metallic component" from conventional removal.

10. Exhibit B is our in-house presentation to the technical staff. I shall not go over it since Harki Singh does so and he establishes that our presentation was prior to the critical Doshita date.

11. Referring to Exhibit C (redacted third party chemical analysis), the mailing date on the first page (C.1) is a date prior to the critical date. Even before this, we (my co-inventors and I) had suspected that the micromasking residue consisted of a silicon oxide umbrella and an underlying Ti containing anchor. The reason was that the silicon oxide umbrella shielded the Ti containing anchor during the etch away of the TiN ARC layer and thereafter the Ti containing anchor shielded underlying oxide when the hard mask was developed by etching with an oxide removing chemistry. So unintended micromask segments were left behind in the hard mask. To verify our suspicions, I had requested of the Evans Analytical Group to perform an in-depth chemical analysis of one of our wafer samples that had micromasking residue on it. The dates (redacted) that I had sent the request in and the dates at which results were mailed back to me are both not only prior to the critical Doshita date but also prior to our sign off date on the Invention Disclosure form. So this demonstrates that we had objective confirmation of our suspicions that the micromasking residue contained a substantial Ti "metallic component". Only pages C.1-C.4 of the twelve page chemical analysis report is included in Exhibit C because pages 5-12 contain mostly very technical

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detail data and graphs of spectroscopy results. Pages C.1-C.4 (with dates redacted) are sufficient to demonstrate that I and my co-inventors appreciated prior to the critical Doshita date and also prior to our Invention Disclosure sign off date that we were dealing with titanium compounds that were forming attachment anchors at the bases of the micromasking residue and with an inorganic oxygen component (the SiO umbrellas) that shielded the titanium compounds during conventional etch away of the TiN ARC layer. Based on our knowledge of the layering of the materials in our process we, appreciated prior to our sign off date in Exhibit A, that we needed to both chemically attack the anchors and mechanically attack (with sputter bombardment) the top of the residue in order to effectively remove it from the substrate. Thus, prior to the critical Doshita date we were in conceptual appreciation of the full scope of the claimed subject matter of our present application. Additionally we had reduced to actual practice prior to the critical Doshita date at least the recipe of example Wf 724(784)-22 of Exhibit A which was a chlorine based etch recipe with Argon based sputter enhancement. Thus the invention had been reduced to actual practice and demonstrated to work for its intended results. Additionally a broader disclosure of the invention had been relayed to the law firm which then diligently filed the application just slightly more than two months after the critical Doshita date

12. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and all statements made herein are made with the knowledge that whoever, in any matter within the jurisdiction of the Patent and Trademark Office, knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statements or representations, or makes or uses any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be subject to the penalties set forth under 18 U.S.C. 1001, and that violations of this paragraph may jeopardize the validity of this

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patent application, or the validity or enforceability of any patent or certificate resulting therefrom.

Signature:

George Kovall

George Kovall

Date:

5/30/08

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